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Observations on the Life Cycle of *Siphloplecton basale* (Walker)

(Ephemeroptera: Metretopodidae)

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Metretopodidae is a small mayfly family placed in the major heptageniod phyletic line, the metretopodids representing a special lineage from the Siphlonurinae (Edmunds, 1972). Several workers, e.g. Berner (1950), Burks (1953), have commented on metretopodids exhibiting features in common with both Heptageniidae and Siphlonuridae. Only two genera are now assigned to Metretopodidae. *Metretopus*, containing a single North American species (*M. borealis* Eaton), is Holarctic and mainly northern. *Siphloplecton* is Nearctic and contains five species. *Siphloplecton* species occur east of the Cordillera over much of North America, usually in slow-flowing streams but occasionally in lakes. *S. basale* is the most widely distributed species, appearing to be most abundant in northern regions.

Detailed life cycle data for North American mayflies are rapidly accumulating, but there are apparently no complete studies for any *Siphloplecton* species. This is especially surprising for the widely distributed *S. basale*, since fully grown nymphs are large, up to 20 mm, and adults, being vigorous fliers with pronounced mottled wings, are easily recognizable on-the-wing. The species is conspicuous enough to be given a special name, Great Speckled Lake Olive, by fly fishermen (Schwiebert, 1973). One reason for the paucity of information, especially nymphal data, is that *S. basale* populations are probably seldom large. But another factor has to do with the habits of the nymphs. The large streamlined nymphs are vigorous swimmers; they not only can avoid standard netting devices, but if caught in anything other than long deep nets they can swim against the current and out of the net. Collecting medium and large size *S. basale* nymphs seems more comparable

to capturing small cyprinids than collecting typical bottom fauna. In fact, Leonard and Leonard (1962) used a fine-meshed minnow seine to collect *S. basale.*

Siphloplecton basale occurs in a small brown-water stream of Alberta, Canada, a stream that has been under continuous investigation since 1966. Except for the initial exploratory study, in which a life cycle approach was used to describe the fauna (Clifford, 1969), no study was designed specifically to gather life cycle data on *S. basale*; and only two *S. basale* nymphs were collected during the 1½ years of the initial study. However considerable information stemming from other studies has now accumulated for *S. basale.* By treating the 10 years of *S. basale* data as an entity, *S. basale*'s life cycle can be described throughout a complete year for the northern stream.

STUDY AREA

The North Fork of the Bigoray River, located in west-central Alberta (53° 25'N, 115° 30'W), is part of the Arctic Ocean drainage. The stream drains extensive muskeg-type terrain. The water color is dark brown during the ice-free season, but the stream becomes quite clear in late winter. At the sampling site, the stream is small (average base flows in winter and summer are 0.14 m^3/s and 0.83 m^3/s respectively), slow-moving (average gradient is 3.0 m/km) and meandering. In late summer, aquatic macrophytes, especially *Sparganium*, cover much of the substrate, which is mainly of sand and silt with lesser amounts of small rubble. The Bigoray River can be described as a chironomid-ostracod type stream, these two taxa collectively comprising on a yearly basis about 49% of the total macroinvertebrate fauna by numbers. Ephemeroptera is the third most abundant taxon, making up 17% of the yearly bottom fauna. There are few resident fish; but shortly after the ice goes out in spring, large numbers of white suckers, *Catostomus commersoni* (Lacépède), make a spawning run into the Bigoray River from the Pembina River.

LIFE CYCLE

Nymphs—Based on 5 years of bottom fauna samples, *S. basale* makes up only a minor component of the total invertebrate fauna in the brown-water stream. Nymphs made up 0.2% of the total yearly bottom fauna and 1.3% of the total yearly mayfly bottom fauna. *Siphloplecton basale* is a univoltine species and generations do not overlap (Fig. 1). New generation nymphs first appear in July. They grow rapidly during the remainder of the ice-free season. From July through November,

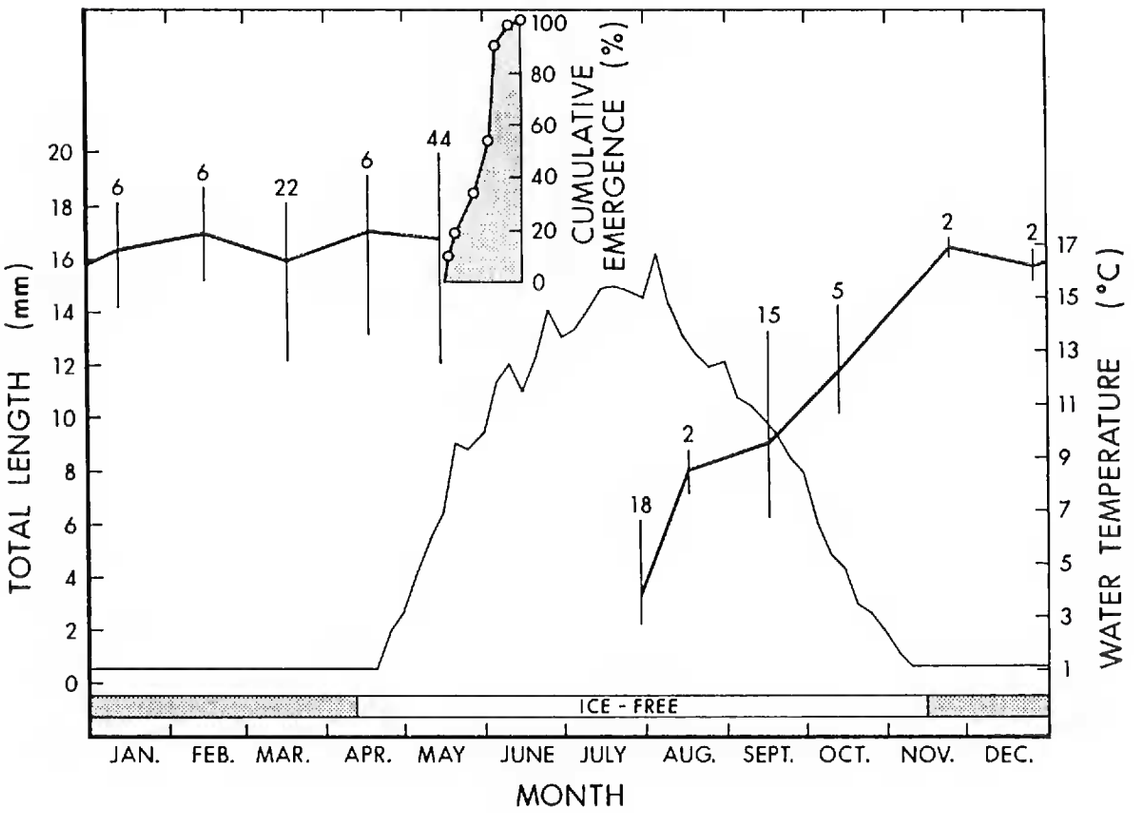

FIG. 1. Growth features and emergence of *S. basale* as related to average 5-day water temperatures and ice conditions. Range and mean size were compiled by measuring nymphs (numbers above range) collected from 1969 through 1975 and treated as monthly samples. Monthly sampling date is expressed as the average of all collecton dates within the month.

nymphs increase in size at a rate of about 0.8 mm per week. Most nymphs appear to be fully grown by November, when the stream becomes completely ice-covered. Nymphs grow very little, if at all, during the long winter. Average ice break-up time at the sampling site is during the second week in April, and shortly after this water temperatures start to rise. Nymphs do not increase very much in total length after the break-up; however development resumes, and the adults usually start emerging during the second or third week of May.

Nymphs smaller than 9 mm seemed to be distributed in a variety of habitats including shallow, fast-moving water; whereas nymphs 9 mm and larger were usually found only in slow-moving water having extensive beds of aquatic macrophytes. Lyman (1956), Lehmkuhl (1970) and Hilsenhoff *et al.* (1972) have all commented on *S. basale* nymphs being most abundant in slow-water along the banks and usually associated with shoreline vegetation. In contrast, Leonard and Leonard (1962) found *S. basale* in deep water having a strong current. In the Bigoray River, *Sparganium* can extend from bank to bank, and the

Table 1. Volume of stomach content items of *S. basale* nymphs. Volumes were determined using a Model TA II Coulter Counter.

Month	Numbers	Average Size (mm)	Average Volumes (mm^3) per stomach			
			Detritus	Diatoms	Sand and Silt	Total
Feb.-March	4	16.0	0.66	0.02	0.01	0.69
May	9	16.5	0.62	0.14	0.02	0.78

large nymphs appeared to be distributed across an entire width transect, but the nymphs are such vigorous swimmers that it was difficult to determine accurately their preferred habitat. Lyman (1955) observed *S. basale* migrating shoreward just prior to emergence in a Michigan lake. During an April–May study of *Leptophlebia cupida*'s upstream migration (Hayden and Clifford, 1974), we found no *S. basale* nymphs moving upstream along the banks or even congregating along the shore.

During a year's study of the drifting organisms (Clifford, 1972), *S. basale* nymphs comprised a total yearly drift density of 304 per 100 m^3 of water filtered. This was 4% of the total yearly mayfly fauna found in the drift. Only 25% of the *S. basale* nymphs were larger than 11 mm. Eighty percent of all drifting *S. basale* nymphs were collected between sunset and sunrise; hence *S. basale* does exhibit a night-active drift pattern.

Nymphs are herbivore—detritivores (Table 1). The stomach analysis, although based on a small sample size, indicates that by late winter the nymphs are almost entirely detritivores; but during the ice-free season prior to emergence, they are partly herbivorous, ingesting living diatom cells. White suckers usually make their spawning run up the Bigoray River at about the time *S. basale* starts emerging, but the nymphs are not a major food item of the suckers (Bond, 1972). Nymphs occurred in the stomachs of 9.5% of the suckers moving upstream from 28 April to 26 May 1969. These nymphs accounted for less than 1.0% of the total number of food items, but 3.9% of the total weight of the stomach contents. There were no *S. basale* nymphs in stomachs of post-spawning suckers moving downstream between 24 May and 4 June 1969, a period when *S. basale* is still emerging.

Adults—Siphloplecton basale is one of the earliest emerging mayflies of the Bigoray River. Subimagos start emerging usually during the second or third week of May, when the water, although still quite cold, is warming rapidly (Fig. 1). Cumulative emergence percentages of Figure 1 were compiled from data of a 1973 emergence study (Boerger

and Clifford, 1975), in which 16 floating box traps, each 0.1 m^2 in area, were arranged in four transects across the stream; the traps were operated continuously from 25 April to 23 October 1973. Total yearly emergence for *S. basale* was 44.5 (18.6 males and 25.9 females) per square meter of substrate, and this accounted for 13% of all mayflies emerging during 1973. Assuming the emergence traps were not somehow biased in favor of collecting disproportionately large numbers of *S. basale*, this figure indicates that *S. basale* is more abundant than would be indicated by bottom fauna samples (1.3% of the total yearly mayfly fauna) or drift samples (4% of the total mayfly fauna).

Adults are present for about 1 month, most of the adults having emerged by the middle of June. The timing of this phenophase in the brown-water stream agrees well with *S. basale* emergence timing in other northern regions: from 23 May to 12 June in Ontario (Clemens, 1915), from 12 May to early June in a Michigan lake (Lyman, 1955), and in early May in Wisconsin (Hilsenhoff *et al.*, 1972).

In the Bigoray River, *S. basale* emerges during full daylight, usually around midday. In Michigan, Lyman (1955) observed a nymph transforming at 1100 hrs and its subimago stage lasting 48 hours. Males have been observed swarming in full daylight of the afternoon and early evening (Clemens, 1915; Lyman, 1955) and full daylight of the morning (present study). Males swarm above water, usually at a height of 3 to 6 meters. Lyman (1955) gives a description of the male's hovering and darting type flight. Leonard and Leonard (1962) noted that once the female enters the swarm and is siezed, the pair rises to treetop level. Spieth (1940) determined that the *S. basale* pair normally remains coupled for no more than 1½ minutes; however when captured in a net, the pair might remain *in copula* for up to 7 minutes. I could not confirm Leonard and Leonard's (1962) observation that ovipositing females sometimes drop their eggs while in flight. In the Bigoray River, all ovipositing females appeared to release a few eggs at a time by momentarily resting on the water's surface or less frequently by dipping the abdomen into the water.

Koss and Edmunds (1974) have described *S. basale*'s egg. For Bigoray River adults, average number of eggs per subimago (average size: 15.5 mm) was 2063 (Clifford and Boerger, 1974). Total potential fecundity generally varied with the female's size. For example, average number of eggs per millimeter size class of subimagos and imagos (that had not oviposited) combined were 1832 (13 mm), 1633 (14 mm), 2043 (15 mm), 2168 (16 mm), 2499 (17 mm), and 3019 (18 mm). Females have a high total potential fecundity relative to that of most

mayflies, but this is because *S. basale* is a large mayfly. Average number of subimago eggs per millimeter of total length was 133, which is about in the middle of the range of all Bigoray River mayflies. The ovoid shaped eggs had an average length of 0.21 mm and average width of 0.14 mm.

I conclude from the 10 years of data that *S. basale* is probably more abundant in streams and lakes than would be indicated by bottom fauna samples, since the large fishlike nymphs can often avoid standard collecting devices. In terms of the Bigoray River's total yearly mayfly fauna, *S. basale* made up only 1.3% of the bottom fauna and 4% of the drift fauna, but the subimagos accounted for 13% of all mayflies emerging.

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SCIENTIFIC NOTE

***Leucopsis klugii* (Hymenoptera, Chalcidoidea) reared from *Xylocopa brasilianorum* (Hymenoptera, Apoidea) in Costa Rica.**—A nest containing 1♀ *Xylocopa brasilianorum* (Linnaeus) was found in a slender fence post on 24 January 1975 near the Palo Verde Research Station, Comelco Property, about 15 km SW Bagaces, Guanacaste Province, Costa Rica. The nest entrance led to a burrow 1.5 cm in diameter that extended lengthwise in the post for 7.4 cm in one direction and 10.4 cm in the other. In the latter section were two completed cells and an incomplete loaf of pollen. In the former section was a pollen loaf with egg, but no pith partition.

The bee larva in the first cell constructed by the female bee had been completely consumed by 11 parasitic larvae. Judging by the amount of bee feces in the cell and the absence of pollen, the bee larva was evidently fully grown before death. Later 5♀♀, 2♂♂ of *Leucopis klugii* Westwood successfully emerged. The wasps have been deposited in the British Museum and their identity kindly confirmed by Z. Bouček. This is the first host record for *L. klugii*. Host bees were previously known for 3 of the 9 species in the Neotropical hopei group to which *L. klugii* belongs (Bouček, 1974, Bull. Brit. Mus. (Nat. Hist.), Suppl. 23: 44). These include species of *Megachile* (Megachilidae) and *Xylocopa* (Apidae).—HOWELL V. DALY, *Department of Entomological Sciences, University of California, Berkeley, California 94720.*